

AP20 Rec'd PCT/PTO 21 JUL 2006

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Description

Method of Converting Aquatic Plants Especially Hyacinth Into Useful Products

Technical Field

The invention relates to conversion of aquatic plants, particularly hyacinth, into useful products.

Background Art

Water hyacinth is a free-floating plant whose leaves are located above water surface and roots below. It multiplies rapidly, clogging lakes, rivers, ponds and seriously obstructing traffic on waterways. Hyacinth is extremely difficult to eradicate and is regarded as a nuisance that must be removed where necessary.

Disclosure Of The Invention

In one aspect, the invention provides a method of converting aquatic plants, especially hyacinth, into liquid fertilizer (foria) and solid residue that comprises plant protein, carbohydrates and fiber. The method comprises placing the aquatic plants in a blending tank together with water, and blending the contents of the tank to produce finely divided plant matter. The finely divided plant matter is preferably, though not necessarily, separated from the water in the blending tank and dried to facilitate transport to a processing plant. An alkaline water solution is formed containing the finely divided plant matter, and agitated to dissolve nutrients contained in the plant matter. The solution which contains the dissolved nutrients is then separated from remaining finely divided plant matter resulting in a liquid fertilizer (the solution) and solid plant residue. The solid residue may be used as animal feedstock or used to produce paper or other products.

The industrial advantage of the process is that aquatic plants, particularly hyacinth, commonly regarded as a nuisance, are converted into useful products. Other aspects of the invention will be apparent from the description of best mode of implementation below.

Brief Description of the Drawings

The invention will be better understood with reference to drawings in which:

fig. 1 is a diagrammatic representation from above of a power boat adapted to gather hyacinth growing in a body of water;

fig. 2 is a diagrammatic representation of equipment for preliminary processing of the harvested hyacinth to produce finely divided plant matter; and,

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fig. 3 is a diagrammatic representation of equipment for converting the finely divided plant matter into liquid fertilizer and solid plant residue and optionally converting the liquid fertilizer into granular form.

Best Mode of Carrying Out the Invention

Reference is made to fig. 1 which shows apparatus for collecting hyacinth in a body of water. The apparatus comprises a power boat adapted for gathering of the hyacinth. The boat comprises a forward collecting structure which may be a simple tubular frame attached to a forward end of the boat and typically having a horizontal span of about 10 meters. The structure may comprise hinges and optionally motor mechanism that permits the structure to be folded into a compact form and extended for purposes of harvesting hyacinth. The forward collecting structure essentially pushes hyacinth plants forward of the boat. A folding rear collecting structure is inclined slightly downward into the water to collect and drag hyacinth plants. Hyacinth in the waters may be cut in advance of collection by the boat or the boat may be fitted with a cutting mechanism comparable to a horizontally oriented chain saw and disposed just below water level to reduce the plants to a more manageable form.

The plants collected by the boat are delivered to a loading area just off shore. There the collected plants are suctioned together with water through a pipe fitted with propelling mechanisms and delivered to a blending tank. A conventional valve control the displacement of water and other materials through the pipe.

The blending tank has an inlet, controlled by an upstream flow valve, where the plants and entraining water are received. It also contains a blade assembly rotated by an electric motor that finely divides the plants. Adequate water should be delivered to the blending tank to permit the plant materials to be finely divided into near-particulate matter. To that end, a sensor detects the level of water in the blending tank, and actuates a pump that introduces additional water until an appropriate volume is achieved. The tank may be provided with a glass viewing port to permit visual inspection of water levels and manual actuation of the pump. The blending tank has an outlet controlled by a downstream flow valve. During blending, the inlets and outlet are closed. The outlet can be opened and an air flow producer operated to pressurize the interior of the blending tank and discharge the finely divided plant matter and water to a drying tank. Typical blending time might be 30 minutes depending on the exact nature of the blade assembly and motor.

The drying tank has an inlet through which the water and finely divided plant material are received. A filter mechanism drains water from the

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bottom of the tank, and an air flow producer can be operated to pressurize the interior of the drying tank to assist in discharging the water. A hot air flow producer is used to agitate the finely divided plant matter, and a vent controlled with a flow valve discharges the heated, damp air flows. When the plant material has dried sufficiently, a downstream valve is opened and the air flow producer is operated to expel the dried materials through an outlet to particulate handling machinery.

The handling machinery includes a reservoir that accumulates the discharged dry materials. The materials are then discharged to a mill that contains a rotary blade assembly operated with an electric motor. The blade assembly may be configured in a conventional manner to produce air flows that entrain the dried plant matter from the reservoir into the mill and then expel the materials through a discharge port controlled by a downstream valve. The discharge port may be coupled to conventional bagging equipment to permit the dried materials to be delivered to a central plant for further processing.

The processing plant comprises a storage tank in which the dry particulate matter is loaded. An air flow producer is configured to discharge the particulate matter with entraining air flows into a processing tank. The processing tank also receives water through a port and granulated chemicals, specifically alkali salts, through a port. Although not shown, level controls may be provided to avoid overfilling. The water and alkali salts form a solution that extracts soluble nutrients from the particulate plant matter. A stirring assembly comprising a rotary blade and electric motor agitate the contents of the processing tank to encourage dissolving of plant nutrients in the liquid within the processing tank. Typical processing time might be 10-15 minutes depending on the exact nature of the equipment used. The solution is then essentially a liquid fertilizer, and the solid residue contains plant proteins, carbohydrates and fiber that can be used in livestock feed or used for paper production. The liquid fertilizer is discharged from the processing tank through an outlet controlled by a valve to a storage tank. The solid residue is then entrained with additional water flows from the storage tank through another outlet and directed to a drying facility, such as the drying tank described above.

Liquid fertilizer is desired can be discharged through a specific outlet associated with the storage tank. If quantities of the alkali, water, and plant material have been preselected to cause the fertilizer solution to solidify, the liquid fertilizer is discharged to a reaction vessel. The reaction between dissolved nutrients and the alkali salts is then allowed to continue until the contents of the reaction vessel solidify. Selection of appropriate quantities of

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reactants simply involves analysis of their constituent materials and conventional calculation of quantities required to completely react the constituent materials. Since fertilizer and feedstock are being produced, the selection of appropriate quantities of reactants is not particularly critical. The solid material is expelled from the reaction vessel with a worm drive that fragments the materials and delivers them to a conventional granulator to produce fine particulate material. That material may then be used as fertilizer or bound with water and sand to produce materials resembling arable soil.

Various products may be produced including liquid fertilizer, pelletized or granulated fertilizer, supplementary salts, and solid residue. Examples of such products are provided below.

LIQUID FERTILIZER

The starting formulation in weight percent may typically be as follows: water 0.1 - 88.0; alkali salts such as sodium carbonate or bicarbonate, 0.1 - 32.3 (potassium, ammonia, silver salts are alternatives), and water hyacinth fine powder 0.1 - 5.5.

First an alkaline solution is formed by combining water and alkali salt and mixed with fine water hyacinth fine powder produced as described above. The mixture is stirred or otherwise agitated vigorously for about 15 to 30 minutes. The solution will typically have a PH of 6 - 13.25. The liquid fertilizer is then separated from solid plant residue. This results in a solid residue can be used as fertilizer and 10 - 25% in concentrated liquid fertilizer which may typically have the following with the following characteristics:

Phosphorus (P_2O_5) 0.0759

Potassium (K_2O) 0.4999

Nitrogen (N) 2.341

Calcium (Ca) Trace

Magnesium (Mg) 0.0289

Copper (Cu) ppm 34

Iron (Fe) ppm 2,149

Zinc (Zn) ppm 411.50

Ph 1% solution 13.22

% Sulphur (S) 0.314%

Sodium (Na) 22.50

Manganese (Mn) ppm 100

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GRANULATED FERTILIZER

The starting formulation comprises in weight percent: water 0.1 - 88.0%; alkali salts based on sodium, potassium, ammonia, silver salts of 0.1 - 32.3%; and water hyacinth fine powder of 0.1 - 5.5 %.

First, the alkaline solution and hyacinth power are combined and stirred vigorously for 45 minutes. The PH may typically range from 6.2 - 13.5. Solid residue is allowed to settle for 48 hours. The solution is then separated and allowed to complete reaction to produce a fertilizer with the following characteristics, in weight percent unless parts per million ("ppm") are indicated:

Phosphorus (P₂O₅) 0.0569

Potassium (K₂O) 0.0903

Nitrogen (N) 2.099

Calcium (Ca) Trace

Magnesium (Mg) 0.0174

Copper (Cu) ppm 34

Iron (Fe) ppm 2243.5

Zinc (Zn) ppm 377.50

PH 1% solution 13.57%

Sulphur (S) 7.847

% Sodium (Na) 21.50

Manganese (Mn) ppm 9.5

SUPPLEMENT SALT

The starting formulation comprises in weight percent water 0.1 - 88; alkali salts (sodium, potassium, ammonia, silver salts) 0.1 - 32.3; hyacinth fine powder of 0.1 - 5.5.

First, an alkaline solution of sodium salt is made and hyacinth particulates are combined and stir vigorously for 45 minutes. The water hyacinth residue is separate, and the resulting solution contains 75 - 90% (by weight) supplement salt. Calcium may be added during or after processing to compensate for the low calcium content of hyacinth plant materials. The final product of supplement salt will contain up to 20% water hyacinth residue as an improvement nutrient, which contains up to 8% crude protein. The supplement salt may typically have the following characteristics in weight percent unless parts per million are indicated.:

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Phosphorus (P₂O₅) 0.0569

Potassium (K₂O) 0.0903

Nitrogen (N) 2.099

Calcium (Ca) Trace

Magnesium (Mg) 0.0174

Copper (Cu) ppm 34

Iron (Fe) ppm 2243.5

Zinc (Zn) ppm 377.50

Ph 1% solution 13.57

% Sulphur (S) 7.847

% Sodium (Na) 21.50

Manganese (Mn) ppm 9.5

COMPOSTED RESIDUE

After water hyacinth has been processed, the solid residue may be sun dried or passed through electric dryer. The plant tissue may be further milled into fine powder that can be used as fertilizer. The plant material has the following characteristics, in weight percent unless parts per million are indicated:

Nitrogen (N) % 3.411

Phosphorus (P) % 0.15

Potassium (K) % 1.69

Magnesium (Mg) ppm 1.290

Copper (Cu) ppm 0.00

Manganese (Mn) ppm 2.105

Iron (Fe) ppm 13.402

Zinc (Z) ppm 0.458

SOLID RESIDUE

After the extraction of liquid fertilizer, the plant residue may serve as fertilizer, raw material to manufacture fodder due to the high content of crude protein, which may typically be in excess of 11%. The residue may typically have the following characteristics, in weight percent unless parts per million are indicated:

Nitrogen (N) % 1.752

Phosphorus (P) % 0.01

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Potassium (K) % 1.044

Magnesium (Mg) ppm 1.631

Copper (Cu) ppm 0.00

Manganese (Mn) ppm 0.819

Iron (Fe) ppm 5.869

Zinc (Z) ppm 0.276

It will be appreciated that modifications may be made to the examples above without necessarily departing from the scope of the claims.